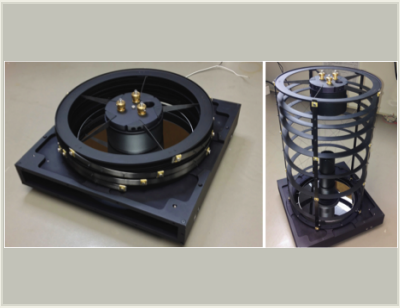
Center Innovation Fund: ARC CIF

Deployable Telescope for Compact Spectropolarimeter

Completed Technology Project (2012 - 2013)

Project Introduction

This work aimed to increase the TRL of the Collapsible Space Telescope's (CST) optical-mechanical performance. Prior to 2013, the CST truss was at TRL=4. However a design incorporating optics and baffles was at TRL=2 (paper design). At the end of this CIF, we have brought the CST's optical-mechanical aspect to TRL=4 in the form of a working lab-bench prototype. Its optical performance is nominal, and our tests have revealed the need for mechanical adjustments to enable proper autonomous deployment and alignment.



FY13 Collapsible Space Telescope lab item in collapsed and deployed configuration shown with manual adjustment screws used to align optical components (gold at top of spider assembly).

Table of Contents

With this Center Innovation Fund we are evaluating the optical and mechanical performance of a collapsible Cassegrain telescope for use as a fore-optic to a compact spectropolarimeter. This effort builds upon previous design work by the NASA Ames Research Center's Small Spacecraft Division on their mechanical-deployment mechanism for a collapsible 152.4mm diameter f/8 Ritchey-Chretien telescope for a 6U (a "U" is a 10-cm cube) spacecraft with an imager as the payload [1]. The 6U spacecraft measures approximately 30 cm x 20 cm x 10 cm. Deployable larger aperture high-throughput telescopes enable scientific investigations on a small spacecraft platform that would otherwise have required larger packaging environments.

Our spectropolarimeter design requires a high-throughput entrance aperture. Obtaining a smallsat-compatible packaging for a telescope and spectropolarimeter provides a unique instrument for future astrobiology remote sensing applications of Earth, Mars, outer planet icy moons, and biosignature studies of exoplanets. Prior to this effort, our baseline aperture diameter for our instrument compatible with a small-sat architecture was 76.2 mm (3-inch). This new collapsible telescope design potentially increases our collecting area by a factor of four, doubling the aperture diameter.

Our CIF 2013's original intent was to design a f/6 version of the Collapsible Space Telescope (CST), as the previous design (TRL 2) was a f/8 system. This change in f/# shortened the truss tube but increased the space behind the primary, the later enabling other instrument types other than a simple detector, and still be compatible with a 6U packaging. Specifically, the back-end instrument was a novel compact no-moving parts spectropolarimeter, with LCROSS and LADEE heritage design, that been proposed to the MatISSE program in 2012. Unfortunately it was not selected in spring 2013. Despite this, this 2013 CIF effort has increased the versatility of the CST concept.

In 2013 we focused on two areas: optical and mechanical. Optically, the two-mirror system was simple but we needed to ensure that the truss structure (which by this time had already been designed) was compatible with the new mirror shapes. Mechanically, the emphasis was placed on an interactive design (heavily using 3D printers) to make the structure stiff when deployed and flexible enough to collapse. Several design parts were made for the first time

Deployable Telescope for Compact Spectropolarimeter

Completed Technology Project (2012 - 2013)

with the intent for improvements such as motorized control and scattered light baffling. The work culminated with a series of lab testing using artificial point sources that we could control their illumination on the telescope and using detectors to ascertain the optical performance.

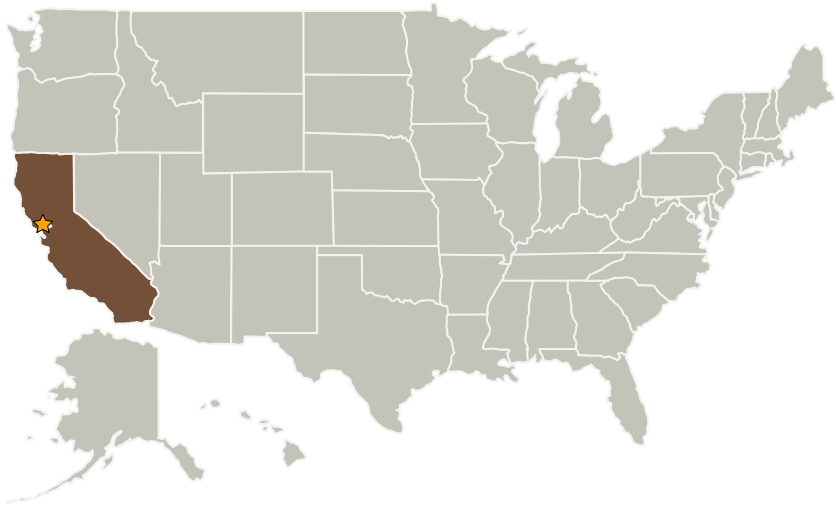
The CST design and current performance (TRL=4) in a laboratory setting was presented at the 2013 Small Satellite Convention in Logan, Utah [2].

References: [1] E. Agasid, A. Rademacher, M. McCullar, R. Gilstrap. "Study to Determine the Feasibility of a Earth Observing Telescope Payload for a 6U Nano Satellite," Final Report for the Innovative Partnership Program, October 2010. [2] Agasid, E., Ennico-Smith, K. & Rademacher, A. "Collapsible Space Telescope (CST) for Nanosatellite Imaging and Observation," SSC13-III-4, Small Satellite Conference (2013).

Anticipated Benefits

Developing a working concept for greater than 4 inch aperture imaging can leverage launch opportunities afforded by standardized 6U deployers such as NLAS and 6U bus heritage from systems like EcAMSat.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Harry Partridge

Principal Investigator:

Kimberly Ennico Smith

Co-Investigators:

Dana H Lynch
Eduardo Bendek
Abraham T Rademacher

Center Innovation Fund: ARC CIF

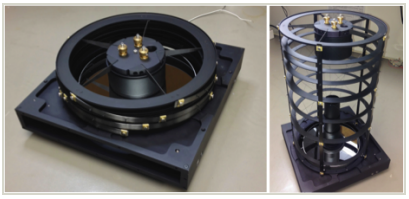
Deployable Telescope for Compact Spectropolarimeter

Completed Technology Project (2012 - 2013)

Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Images



NASA Ames Collapsible Space Telescope
FY13 Collapsible Space Telescope lab item in collapsed and deployed configuration shown with manual adjustment screws used to align optical components (gold at top of spider assembly).
(https://techport.nasa.gov/image/2964)

Stories

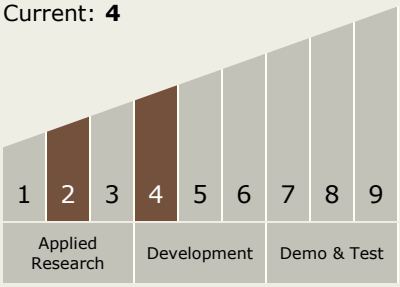
1676 Approval from Ames (#17536)
(https://techport.nasa.gov/file/8734)

Links

Collapsible Space Telescope (CST) for Nanosatellite Imaging and Observation
(http://digitalcommons.usu.edu/smallsat/2013/all2013/62/)

Technology Maturity (TRL)

Start: **2**
Current: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.2 Structures and Antennas